

## Module 7 - Frequency Filters

ME3023 - Measurements in Mechanical Systems

Mechanical Engineering

Tennessee Technological University

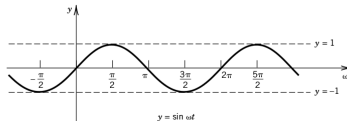
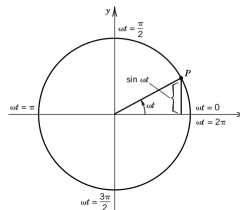
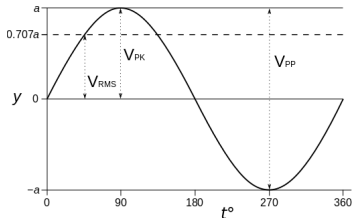
### Topic 1 - What is a Frequency Filter

## Topic 1 - What is a Frequency Filter

- Signal, Amplitude, and Frequency
- Filter Concept
- High-Pass, Low-Pass, and Band-Pass
- Applications

# Signal, Amplitude, and Frequency

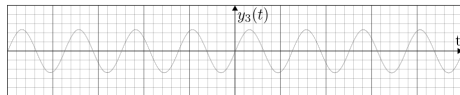
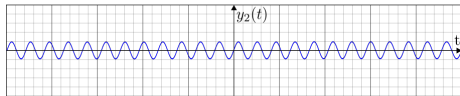
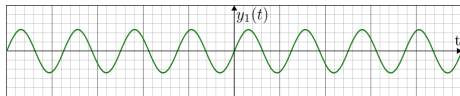
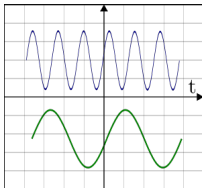
## Signal, Amplitude, and Frequency



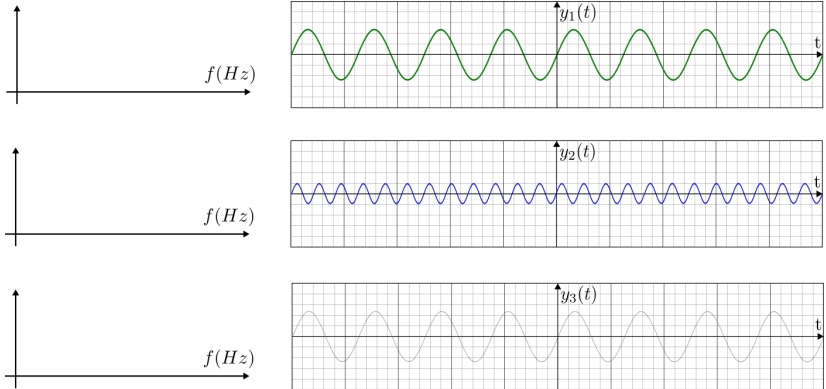
What is the relationship between the unit circle and frequency?

# Signal, Amplitude, and Frequency

Signals can be composed of multiple *frequency components*.  
(see Fourier Analysis Ch2).

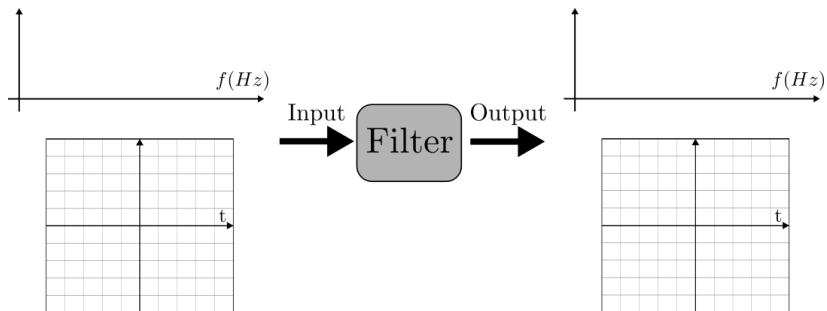


# Signal, Amplitude, and Frequency



# Filter Concept

A raw signal is input to a frequency filter and a filtered signal is output.



# Filter Concept

So what is inside the *grey box*?



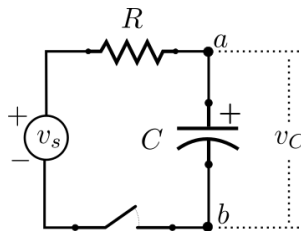
How does it work?

# Filter Concept

Filters are constructed from time-varying circuits. The most basic of which is the **RC filter**.

First Order Model

$$\tau \dot{y} + y = KA \sin(\omega t)$$

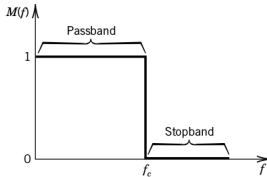


Response Equation

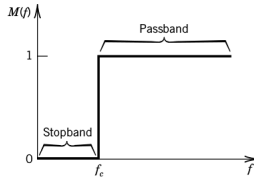
$$y(t) = Ce^{-\frac{t}{\tau}} + \frac{KA}{\sqrt{1 + (\omega\tau)^2}} \sin(\omega t - \tan^{-1}(\omega\tau))$$



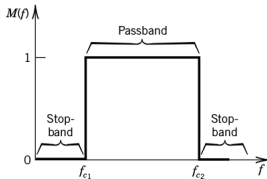
# High-Pass, Low-Pass, and Band-Pass



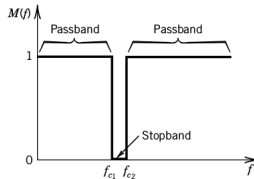
(a) Low-pass filter



(b) High-pass filter



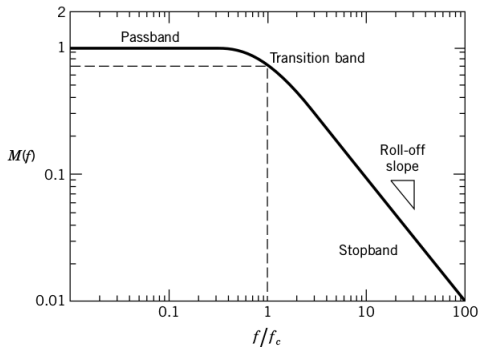
(c) Bandpass filter



(d) Notch filter

# High-Pass, Low-Pass, and Band-Pass

Physical frequency filters do not behave in an ideal manner as the previous figure shows. The filter characteristics are frequency dependent.



# Applications

Finally, what are filters used for?

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